

### **REMARKS/ARGUMENTS**

Claims 1, 42-56, 59-83 and 85-110 are now pending. Claim 64 was amended to depend on claim 1. Claim 84 was cancelled as redundant to claim 72 and the claims previously dependent on claim 84 have been amended to depend on claim 72. Claim 104 was amended to correct an obvious typographical error. With the present amendments all claims are now directed to methods of replicating patterns having nanoscale features smaller than 200 nanometers.

Applicant respectfully traverse rejections of claims 1, 42-56, 59-83, 85-104, 107 and 110 as obvious in view of Napoli in combination with EPA 884 and the rejections of claims 105, 106, 108 and 109 as obvious in view of Napoli. Applicant invented and disclosed methods and processes of replicating sub-200 nm nanometer features using a mold surface to imprint a substrate-supported layer. The methods and processes are distinctively different from the primary reference to Napoli. Napoli did not achieve sub-200 nanometer features and could not reasonably be expected to do so. The secondary EPA 884 reference, cited primarily for disclosure of a mold release layer, does not correct the deficiencies of Napoli and could not reasonably be expected to do so.

### **Background**

Lithography is a key technology in the fabrication of semiconductor devices such as integrated circuits and other important electronic, magnetic, optical and biological devices. At the time the earliest parent application of this case was filed, the dominant

method of lithography used in the semiconductor industry was optical lithography. Optical lithography doesn't imprint a molding surface. It uses light projecting through a mask to expose a photoresist-covered substrate. The minimum size lateral feature of the patterns thus replicated determines how small an integrated circuit can be and how fast it can operate, e.g. process information. In 1994-95 the state-of-the-art optical lithography in the semiconductor industry was about one-half micrometer (500 nanometers).

The semiconductor industry was under substantial pressure to provide circuits of faster speed (smaller circuit components) and greater functionality (more circuit components per unit area). As a consequence of this pressure, the industry sought to develop new generations of integrated circuits having patterns with sub-200 nanometer features.

But conventional optical lithography could not economically replicate such tiny features. Optical lithography is limited by diffraction effects to features having a minimum lateral dimension of approximately one-half the wavelength of the light used to expose the photoresist. The light used to make half-micron circuits is not sufficiently short wave to make sub-200 nanometer features. Deep ultraviolet light is sufficiently short wave but it is difficult to generate, direct and control, resulting in high equipment expense. Electron beam lithography can make sub-200 nanometer features but requires expensive equipment and is tediously slow.

The semiconductor industry recognized that scaling down to sub-200 nanometer features was a major problem vital to the development of future generations of integrated circuits. In 1994 the Semiconductor Industry Association, an international consortium of semiconductor device manufactures, convened a panel of 25 of the world's leading lithography experts to prepare "roadmap" guidelines for the development of future generations of integrated circuits. This panel enumerated a number of possible approaches it deemed worthy of exploration. It is noteworthy that none of the approaches recommended in 1994 were mold imprint lithography.

The Applicant, Stephen Y. Chou, currently a Professor at Princeton University and previously a Professor at the University of Minnesota when he made the present invention, has devoted much of his career to the development of technology for patterning nanostructures. He developed and demonstrated a mold imprint lithography that with inexpensive equipment can quickly replicate features with minimum lateral dimensions as tiny as 25 nanometers or less. This development, which he refers to as nanoimprint lithography, has been widely acclaimed by his peers and technical societies. It has also been selected by Sematech, a national research consortium of U.S. semiconductor device manufacturers, for incorporation into the manufacture of future generations of integrated circuits.

### **The Prior Art**

The primary reference relied upon by the Examiner for rejection of all claims is United States Patent No. 4,731,155 issued to Napoli, et al. on March 15, 1988. Napoli discloses a type of imprint lithography which he characterizes as embossing (and is referred to herein as "thermal embossing"). He uses a metal mold (nickel) to imprint a layer of thermoplastic resin material disposed on a substrate. A thermoplastic resin does not have a precise melting temperature. Heated sufficiently above its "glass transition temperature" it will liquefy into a viscous liquid capable of flowing. Cooled sufficiently below its glass transition temperature it will solidify. There are ranges of temperatures and degrees of viscosity between the liquid and the solid states.

In Napoli's thermal embossing process the thermoplastic layer is heated above the glass transition temperature to liquefy it. The metal mold is imprinted into the liquid thermoplastic and kept there until the thermoplastic cools sufficiently below the glass transition temperature to solidify and thereby retain the imprinted pattern. This necessity of subjecting the metal mold to a range of temperatures during embossing will be shown to be one of the several factors limiting the resolution that Napoli can achieve. Napoli's smallest demonstrated feature was about 700 nanometers. He implied that the method could replicate features "as small as" 600 nanometers.

The secondary reference is EPA 884 published November 11, 1987. According to EPA 884, molds "of a metal such as Ni, Al, Ag, or of glass or quartz" have a hydrophilic, inorganic surface. Such molds are provided with a release layer by treating

the mold with a silane compound having inert attached groups. The result is a release layer having a very small thickness (p. 4, lines 23-29):

"Due to the very small thickness, the structure of the inorganic surface remains substantially unchanged. Consequently, by means of the mold manufactured in accordance with the invention very accurate replicas can be produced."

EPA 884 proposes as application of such molds the manufacture of lenses, mirrors and projection television screens (p. 5, line 29 and p. 6, line 4):

"The mold manufactured by the method in accordance with the invention may be used, for example, for the manufacture of synthetic resin optical components which are provided with a synthetic resin coating layer. The mold is made of, for example, Al, stainless steel, quartz or a synthetic resin which is provided with a layer of SiO<sub>2</sub>. A nonlayer of the silane compound is applied in accordance with the inventive method to the inorganic, hydrophilic surface of the mould which during operation contacts the synthetic resin of the replica to be made. A further example is a Ni mould, the surface of which is modified in accordance with the process of the invention and which is used for the production of projection television screens."

Fig. 1 of EPA 884 is a cross sectional view of a treated mold "designed for producing optical components, in particular lenses" (p. 6, lines 20-21).

### **The Rejections of the Parties**

The Examiner's basic position is that Napoli teaches a process similar to Applicant's and that with the passage of time from Napoli's issue date to Applicant's

filing date the skill in the art would have risen to a level that would have made it obvious to modify Napoli to attain sub-200 nanometer structures. Applicant respectfully disputes this.

Applicant herewith submits evidence that he has invented new ways of achieving sub-200 nanometer structures using imprint lithography (Exhibits A-E attached hereto). Applicant's ways have either not been taught by Napoli or are opposite from the ways of Napoli. Applicant further submits that Napoli alone or in combination with EPA 884 could not achieve, and could not be expected to achieve, sub-200 nanometer features.

The differences between Applicant's approach and Napoli's, alone or in combination with EPA 884, are many fold. They include differences in 1) the molding process and moldable material, 2) mold protruding feature depth, 3) molding layer thickness, 4) mold stiffness and deformation, and 5) mold material. The differences help account for Applicant's surprisingly enhanced resolution and are the result of advanced research rather than the "passage of time". These differences are described in the order presented.

**1. Molding Process and Moldable Material**

Napoli teaches no imprinting process other than thermal embossing using a metal mold to emboss a thermoplastic resist. (Exhibit A, Par. 14). Thermal embossing of a thermoplastic resist requires heating the resist above its glass transition temperature to soften the resist. This means that the mold must also be heated above the glass

transition temperature. The mold must also be permitted to cool below the transition temperature so that the thermoplastic will retain the embossed pattern. But metal molds have a relatively high coefficient of thermal expansion. The consequence of using metal molds with thermal embossing is a lateral thermal shift in the cooling metal mold. For example, nickel, which Napoli taught for molds, has a thermal expansion coefficient of  $13 \times 10^{-6}/^{\circ}\text{C}$ . For a 150 C temperature change, the mold dimension would change 0.2 percent. Such a change would prevent accurate replication of sub-200 nanometer features. (Exhibit A, Par. 17). In contrast, the present application teaches a variety of imprinting techniques beyond thermal embossing including techniques using resists (imprinting materials) which are not thermoplastics and are hardened by processes other than cooling, e.g. irradiation, curing or chemical reaction. (Exhibit A, Par. 16).

## **2. Mold Protruding Feature Depth**

Napoli does not teach limits to the depth of protruding features on the mold. But for making sub-200 nm structures, if the depth is too large, the sub-200 nm protruding mold features can be easily broken during the separation of the mold and the moldable material preventing successful molding (imprinting) of such structures. In contrast, Applicant teaches that for sub-200 nanometer imprinting, the depth of the mold protruding feature should be 5 to 200 nanometers.

## **3. Molding Layer Thickness**

After imprinting a protruding feature into a polymer layer on a substrate there remains a residual layer of the polymer in the trench region formed by the projecting feature. This residual layer is typically etched away to expose the substrate for further processing. Napoli teaches the use of a resist film having a thickness "between 0.5 and 1.5, preferably about 1.0 micrometers." With such resist thickness and a mold protrusion depth of less than 200 nanometers, the etching away of the residue resist would take too long, leading to excessive etching of the lateral dimension of the resist, hence widening or even completely etching away minute features imprinted in the resist and preventing accurate replication of sub-200 nanometer feature. In contrast, the present application teaches that the thickness of a typical resist film is 250 nanometers or less. Accurate replication of sub-200 nanometer features is demonstrated. (Exhibit A, Par. 20).

#### **4. Mold Stiffness and Deformation**

Napoli teaches the use of a metal mold (e.g. nickel) to thermally emboss a thermoplastic resist on a substrate of semiconductor (e.g. silicon). He teaches no molds other than metal molds, and demonstrates no molds other than nickel molds. He teaches no process other than thermal embossing of a thermoplastic resist. The mismatch of the thermal expansion between the nickel mold or other metal mold and the substrate can deform or tear off the structures of sub-200 nm dimensions. Napoli does not teach about the effect of thermal expansion nor about any other effects of



mold deformation. In contrast, the present application teaches that the mold must not only be hard relative to the softened resist film but also must be stiff to reduce bending while forming the imprint. Such bending leads to deformation in the pattern formed in the film. Napoli, et al. is devoid of corresponding teachings. (Exhibit A, Par. 21).

#### **5. Mold Material**

Napoli teaches the use of mold of metal (e.g. nickel) to thermally emboss a thermoplastic resist on a substrate of semiconductor (e.g. silicon). He teaches no molds other than metal molds, and demonstrates no molds other than nickel molds. (Exhibit A, Par. 14). In contrast, the present application teaches molds made of materials in addition to metals including "dielectrics, semiconductors, ceramics or their combination." The present application demonstrates use of a silicon dioxide mold. Silicon dioxide has a thermal expansion of  $5 \times 10^{-7}/^{\circ}\text{C}$ . For a  $150^{\circ}\text{C}$  temperature change, the silicon dioxide mold dimension changes only 0.0075 percent. (Exhibit A, Par. 16).

#### **EPA 884 Does Not Correct the Deficiencies of Napoli for Sub-200**

##### **Nanometer Lithography.**

EPA 884 teaches the use of a molecular monolayer release material on a molding surface. It also teaches the use of such molds to mold polymer devices such as lenses, mirrors and television screens. These are macroscale rather than nanoscale devices. EPA 884 does not discuss imprint lithography or how to imprint sub-200 nanometer features. It not discuss the thermal shift of a metal mold during thermal

embossing or the effect such shift would have on a sub-200 nanometer protruding feature imprinted in a viscous, solidifying thermoplastic. It does not discuss the breakage of the sub-200 nanometer protruding features or the appropriate depth of such features. It says nothing concerning the thickness of the moldable material and nothing concerning the appropriate thickness of moldable material for sub-200 nanometer replication. And while EPA 884 mentions numerous molding materials, it says nothing concerning the need for stiffness in replicating patterns with sub-200 nanometer resolution. In short, EPA 884 does not remedy the deficiencies of Napoli.

The combination of Napoli with EPA 884 would presumably reduce the thickness of Napoli's 40 nanometer thick release layer. But even assuming that the EPA 884 reduces the release layer in Napoli's case to zero thickness., the reduction in lateral feature size would be no more than twice the 40 nanometer thickness or 80 nanometers. This reduces Napoli's 600-700 nanometer lateral dimensions to 520-620 nanometer dimensions, which still falls short of the 500 nanometer state-of-the-art for optical lithography and far short of Applicant's sub-200 nanometer lithography.

#### **The Issue of Prima Facie Obviousness**

The rejections of Applicant's claims maintain that the reduction in size is entitled to little weight in determining patentability and that given the passage of time between Napoli issue date and Applicant's filing date, the skill in the art would have increased to make obvious whatever modifications of Napoli necessary to achieve sub-200

nanometer resolution. But mere assertion is no substitute for proof of the level of skill in the art. The mere passage of time does not demonstrate any particular level of skill or any particular increase in the level of skill. Even more significant, unsubstantiated "skill in the art" is no substitute for applicable prior art.

**Applicant's Evidence of Invention**

Applicant has here presented evidence of invention. The evidence includes the Declaration of Professor Chou, who spent years of research to achieve sub-200 nanometer imprint lithography. The declaration points out a number of deficiencies in Napoli that would prevent sub-200 nanometer resolution. Thus Applicant has demonstrated that a number of problems neither mentioned nor resolved in Napoli had to be recognized and overcome for the achievement of sub-200 nanometer imprint lithography. Applicant further contends that the ability to replicate sub-200 nanometer features economically by imprint lithography is itself an unexpected result of substantial consequence and has presented evidence to that effect.

Other evidence enclosed herewith shows that prior to the time of filing this application: 1) the semiconductor industry recognized a critical need for an economical sub-200 nanometer lithography for new generations of integrated circuits; 2) because of this critical need, the industry convened a panel of leading lithography experts to prepare "roadmap" guidelines for the development of sub-200 nanometer lithography; and 3) after Applicant demonstrated sub-200 nanometer imprint lithography (termed

nanoimprint lithography) it was recognized as a leading approach for the fabrication of new generations of semiconductor and nanoscale devices

### **The Applicable Law**

The factual inquiries for determining obviousness under 35 U.S.C. Section 103 were set forth by the Supreme Court in Graham v. John Deere Co., 383 U.S. 1, 148 USPQ 459 (1966). They include: 1) determining the scope and content of the prior art; 2) ascertaining the difference between the prior art and the claims at issue; 3) resolving the level of ordinary skill in the pertinent art; and 4) considering objective evidence presented to indicate obviousness or nonobviousness.

The burden of establishing nonobviousness rests squarely with the Examiner. See Ex Parte Skinner, 2 USPQ 2d 1788, 1789 (Bd. Pat. App. & Inter. 1986); MPEP §2142. The Examiner has the burden for each and every claim he rejects. Ex Parte Cohen, BPAI Appeal 2007 – 4368 (December 31, 2007).

To establish prima facie obviousness three basic criteria must be met. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art to modify the reference or to combine the reference teachings. Second, there must be a reasonable expectation of success. And third, the prior art reference (or references when combined) must teach or suggest all the claim limitations.

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The teaching or suggestion to make the claimed combination and the reasonable expectation of success must both be found in the prior art, not in Applicant's disclosure. MPEP 3143; In re McLaughlan, 443 F.2d 1392, 170 USPQ 209 (CCPA 1970). Nor can they be inferred from skill in the art, In re Rouffet, 149 F.3d 1350, 47USPQ 2d 1453 (Fed Cir. 1998)

Rejections on obviousness grounds cannot be sustained by mere conclusory statements. Instead, there must be some articulated reasoning with some rational underpinning to support the legal conclusion of obviousness. KSR Int'l Co. v. Teleflex, Inc., 550 U.S., 82 USPQ 2d 1385, 1396 (2007), quoting with approval In re Kahn, 78 USPQ 1329, 1336; 441 F.3d 977, 988 (Fed. Cir. 2006). In particular, unsupported assertions of "skill on the art" are no substitute for applicable prior art. W.L. Gore & Assoc., Inc. v. Garlock, Inc., 721 F.2d 1540, 1553, 220 USPQ 303, 312-13 (Fed. Cir. 1983):

"To imbue one of ordinary skill in the art with knowledge of the invention in suit, when no prior art reference or references of record convey or suggest that knowledge, is to fall victim to the insidious effect of a hindsight syndrome wherein that which only the inventor taught is used against its teacher."

See also AI-Site Corp. v. VSI Intern., Inc., 174 F.3d 1308, 50 USPQ 2d 1161, (Fed. Cir. 1999):

"Rarely...will the skill in the art component operate to supply missing knowledge or prior art to reach an obviousness judgment \*\*\* Skill in the art does not act as a bridge over gaps in the substantive presentation of an obviousness case,

but instead supplies the primary guarantee of objectivity in the process." [Citation omitted].

The risk of the rote invocation of "skill in the art" in obviousness rejections in a slightly different context was pointed out by the Federal Circuit in In re Rouffet, supra:

"If such a rote invocation could suffice to supply a motivation to combine the more sophisticated scientific fields would rarely, if ever, experience a patentable technical advance. Instead, in complex scientific fields, the Board could routinely identify the prior art elements in an application, involve the lofty level of skill, and rest its case for rejection."

The simplicity of an invention does not indicate obviousness. In fact, "the simplicity of new inventions is often times the very thing that is not obvious before they are made." In re Sporck, 301 Fd 686, 133 USPQ 360, 363 (CCPA 1962). Moreover nonobviousness may be based on the recognition of a problem even though its solution, once the problem is recognized, seems simple. Eibel Process Co. v. Minnesota & Ontario Paper Co., 261 U.S. 45 (1923).

#### **The Failure to Present A Prima Facie Case of Obviousness.**

It is the Examiner's burden to establish prima facie obviousness. Ex Parte Skinner, supra. To establish prima facie obviousness based on a combination of references it must be shown that 1) there is some suggestion or motivation to combine the references, 2) that there is reasonable expectation of success, and 3) that the combination teaches or suggests all the claim limitations.

In the present case the Examiner has not met his burden of establishing a prima facie case. The primary reference to Napoli (700-600 nanometer resolution using a 40 nanometer release coating) might arguably be combined with EPA 884 to substitute a monomolecular layer for the 40 nanometer coating. But even if this is done, there is no reasonable expectation of producing sub-200 nanometer resolution. As Applicant has pointed out, reducing Napoli's release coating on a protruding mold feature from 40 nanometers to zero could only be expected to achieve resolution of 620-520 nanometers. Thus the proposed combination could not reasonably be expected to be superior to state-of-the-art optical lithography (500 nanometers) nor to achieve Applicant's unexpectedly high resolutions in the sub-200 nanometer range. Unsupported assertions about the passage of time and the skill in the art simply do not bridge this enormously significant gap. See Al-Site Corp. v. VSI Intern., Inc., supra and W.L. Gore & Assoc., Inc. v. Garlock, Inc., supra.

**The Evidence Presented Shows That Napoli Teaches Away From Methods For Achieving Sub-200 Nanometer Lithography**

**1. The Documentary Evidence.**

The evidence of invention submitted by Applicant during the prosecution of this Application is included in the attached Evidence Appendix. It consists of the following:

<u>Exhibit</u>	<u>Item</u>
A	Declaration of Stephen Y. Chou

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- B Publication List of publications of Professor Chou relating to nanotechnology (Exhibit 1 to Declaration)
- C News Release of the National Academies, "National Academy of Engineering Elects 64 Members and Nine Foreign Associates," February 9, 2007 (Exhibit 2 to Declaration)
- D Semiconductor Industry Association, The National Technology Roadmap for Semiconductors, Chapter on "Lithography," pp. 81-93 and A2 (1994). (Exhibit3 to Declaration)
- E IEEE News, "IEEE Honors Princeton Nanotechnologist," December 1, 2004

This evidence demonstrates the existence of significant technical barriers between the 600-700 nanometer thermal embossing of Napoli and Applicant's sub-200 nanoimprint lithography. It further demonstrates that breaking through those barriers was unexpected and fulfilled a critical need in the semiconductor industry for economical sub-200 nanometer lithography. It was widely hailed by Applicant's peers and was adopted by the semiconductor industry for future generations of integrated circuits.

Here documents submitted with the Declaration of Professor Chou (Exhibit A) qualify him as an expert. The Declaration sets forth that he is the Joseph C. Elgin Professor of Engineering at Princeton University and a Professor of Electrical



Engineering. He received his Ph.D in Physics from the Massachusetts Institute of Technology in 1986, and he has been engaged in research and development in the field of nanotechnology since 1982. Exhibit 1 to his Declaration (Exhibit B here) lists the titles of his Journal Papers, Plenary Talks, and Conference Papers and Presentations relating to nanotechnology. The list of titles alone numbers thirty-seven pages. In 2004 he received the IEEE Brunette Award "for the invention and development of tools for nanoscale patterning, especially nanoimprint lithography, and for scaling of devices into new physical regimes," Exhibit 4 to the Declaration (Exhibit E here). In 2007 he was elected Member of the National Academy of Engineering for "contributions to nanoscale patterning and to the scaling of electronic, photonic, magnetic and biological devices," Exhibit 2 to the Declaration (Exhibit C here). It is submitted that this training, experience and recognition establish Professor Chou as an expert in the field of nanotechnology.

**The Declaration Evidence Demonstrates That Napoli Teaches Away From Methods That Could Achieve Sub-200 Nanometer Resolution.**

Professor Chou's Declaration points out some of the reasons the Napoli thermal embossing process is unsuitable for sub-200 nanometer lithography. It notes that Napoli uses a mold of metal (e.g. nickel) to thermally emboss a thermoplastic resist on a substrate (Exhibit A, Par. 14). Thermal embossing of a thermoplastic resist requires that the mold be heated above the glass transition temperature of the thermoplastic to

soften the resist. The mold must also be permitted to cool below the transition temperature so that the thermoplastic will harden. But metal molds have a relatively high coefficient of thermal expansion. The consequence of using metal molds with thermal embossing is a thermal shift in the cooling metal mold. For example, nickel, which Napoli taught for molds, has a thermal expansion coefficient of  $13 \times 10^{-6}/^{\circ}\text{C}$ . For a  $150^{\circ}$  temperature change, the mold dimension would change 0.2 percent. Such a change would prevent accurate replication of sub-200 nanometer features (Exhibit A, Par. 15).

Yet another problem is Napoli's specification of a resist film having a thickness "between 0.5 and 1.5, preferably about 1.0 micrometers" (U.S. Patent No. 4,731,155, col. 2, lines 39-42). The Declaration points out (Exhibit A, Par. 19):

"After imprinting a protruding feature into a polymer layer on a substrate there remains a residual layer of the polymer in the trench region formed by the projecting feature. This residual layer is typically etched away to expose the substrate for further processing. \*\*\* With such resist thickness and a typical mold protrusion depth of less than 200 nanometers, the etching away of the residue resist would take too long, leading to excessive etching of the lateral dimension of the resist, hence widening or etching away minute features imprinted in the resist and preventing accurate replication of sub-200 nanometer features."

In addition, to avoid deformation of the pattern formed in the film, the mold must not only be hard relative to the softened resist but also must be stiff to reduce bending

while forming the imprint. Such bending leads to deformation on the pattern formed in the film. (Exhibit A, Par. 21).

Prior Office Actions dismiss Applicant's achievement of nanoscale resolution with conclusory assertions that with "the passage of time" their solution would be obvious to those of ordinary skill in the art. However, nothing in Napoli fosters any reasonable expectation that his thermal embossing could be modified to sub-200 nanometer resolution. Napoli teaches no process other than thermal embossing of a thermoplastic resist with metal molds. (Exhibit A, Par. 14). He does not describe or teach the effects of the resist film thickness on the final imprinted feature and size; and he does not describe or teach the effect of mold bending on the pattern formed.

**The Declaration and Documentary Evidence Provides Objective Evidence of Nonobviousness.**

As stated in Graham v. John Deere, Co., *supra*, a fourth factual inquiry for determining obviousness is considering objective evidence presented to indicate obviousness or nonobviousness. Objective evidence steps away from the paper trail of patent prosecution and looks at the real world effects of an invention. Important objective evidence of nonobviousness includes contemporaneous recognition of the invention, appreciation by contemporaries skilled in the field, and industry acceptance of the invention. See, for example, Vulcan Engineering Co. v. Fata Aluminum, Inc., 278

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F.3d 1366, 61 USPQ 2d 1545 (Fed. Cir. 2002) and Diversitech Corp. v. Century Steps, Inc., 850 F.2d 675, 679; 7 USPQ 2d 1315, 1319 (Fed. Cir. 1988).

Appreciation and recognition by contemporaries skilled in the art are shown by the IEEE awarding Professor Chou the 2004 Brunette Award. The stated reasons for the award are:

“...for the invention and development of tools for nanoscale patterning, especially nanoimprint lithography, and for the scaling devices into new physical regimes” (Exhibit E).

Such appreciation and recognition are also shown by the National Academies (an umbrella organization including the National Academy of Sciences, the National Academy of Engineering, the Institute of Medicine and the National Research Counsel). In the release announcing Professor Chou's election as Member of the National Academy of engineering, they stated in the brief statement of his principal engineering accomplishments (Exhibit C):

“For contributions to nanoscale patterning and to the scaling of electronic, photonic, magnetic and biological devices.”

And industry acceptance is shown by the fact that of the semiconductor industry, which in 1994 did not consider thermal embossing as a potential solution to its need for an economical sub-200 nanometer lithography, subsequently chose Applicant's nanoimprint lithography “as one of the next generation lithographies for semiconductor integrated circuits.” (Exhibit A, Par 23; Exhibit E).

### **Conclusion**

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In view of the foregoing it is respectfully submitted that claims 1, 42-56, 59-83, and 85-110 are patentable over Napoli alone or in combination with EPA 884. Accordingly this application now fully complies with the requirements of 35 U.S.C. § 103 and is now in condition for allowance. Reconsideration and favorable action in this regard is therefore earnestly solicited.

Respectfully Submitted,

/Glen E. Books/

Glen E. Books, Reg. No. 24,950  
Polster, Lieder, Woodruff & Lucchesi, L.C.  
Customer Number: 001688  
12412 Powerscourt Drive  
St. Louis, Missouri 63131-3615  
Telephone: (908) 204-0128 / (314) 238-2400  
Facsimile: (314) 238-2401